3rd Quarter 2008
Issue 4

ERDC Topographic Engineering Center

BTRA-BC/ J-GES

Quarterly Gazette

Inside this issue:

In every issue:

From the Program Manager ...

Since the last edition, both programs have had tremendous successes. Through the outstanding teamwork of the Government, Industry, and Academia, the Engineering Research and Development Center - wide Geospatial-Battle Management Language demo received high praise and accolades. We also successfully executed three J-GES experiments: J-GES Value Experiment #2, Replication/ Synchronization Experiment #2, and a series of BTRA Engine architecture experiments. More information on all of these are included in this edition. As always, our bottom line is tangible products and support to the war fighter!

- Dan Visone, PM BTRA BC/J-GES

Mr. Robert Burkhardt, Army GIO, Mr. Mark Hainsey, Director, GASO, and Mr. Juan Perez, Director, TEC Systems Division join in discussion during the ERDC-wide GeoBML demonstration.

The BTRA-BC Battle Engine, Part II

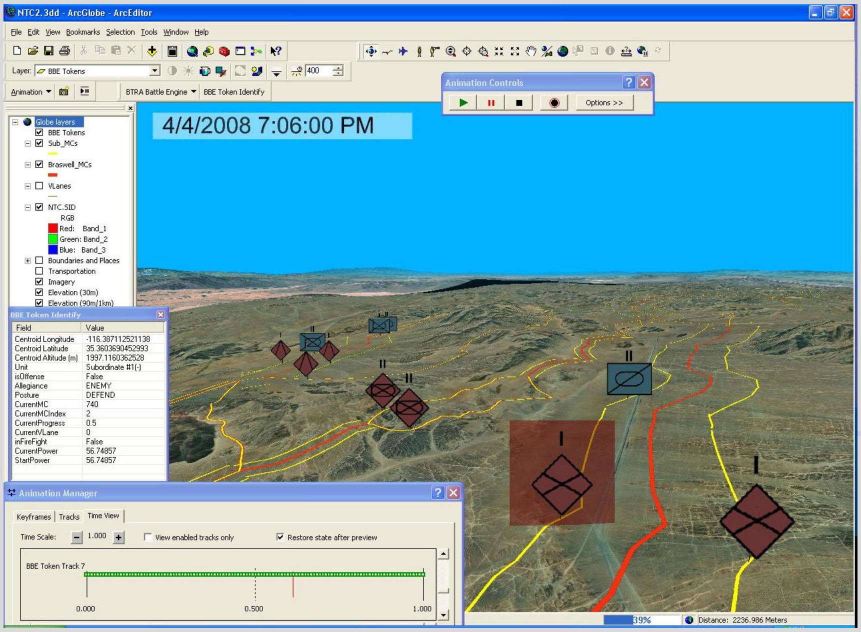
- By Jerry Schlabach

"Take calculated risks. This is quite different from being rash."
- George S. Patton

In Volume 3 (2 Qtr 2008) of the BTRA BC/J-GES Gazette, we provided a basic overview of the BTRA-BC Battle Engine (BBE), which 'cognitively amplifies' the ability of battle staff planners to conduct the Military Decision Making Process (MDMP) and Intelligence Preparation of the Battlefield (IPB). BBE accomplishes this by enabling the human-computer reasoning team to develop and analyze tactical Courses of Action (COA) much faster and better than humans alone. In this issue we highlight 'BBE Complex View' (BCV), which provides animated visualizations of BBE-produced war games. We also highlight the several Friendly Course of Action (FCOA) - comparison analytic tools provided in BBE.

BBE Complex View:

The diagram to the right shows a screen grab from BCV's visualization of a BBE-produced war-game. The animation controls enable the user to move the time of the display forward or backward within the war-game animation. The data display window shows current battle information of the selected token, appropriate for the displayed war-game time-slice. The selected token in this screen grab is the enemy infantry company surrounded by a transparent reddish-brown selection box.



BBE Complex View provides for war-game animation.

BCV was developed by Jason Newmoyer of ESRI Defense Services, using a Beta Prototype for Arc-Globe version 9.3. Naturally, BCV offers the normal advantages of operating within the ESRI environment, to include the ability to display geo-spatially rectified map layers developed from any source using a C/JTMK or ESRI application. This will be particularly useful for users who would like to simultaneously display terrain analysis products developed from BTRA-classic tools. BCV also provides normal ArcGlobe visualization tools such as fly-through and walk-through navigation and perspectives. BCV can also display a classic 2D perspective for a more traditional visualization.

ESRI

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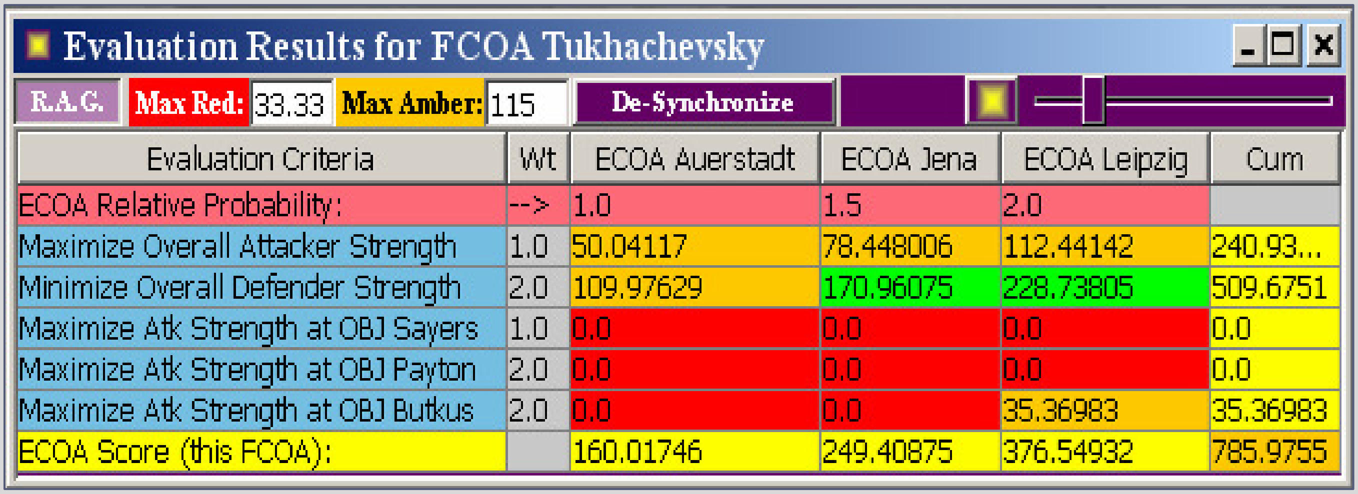
BBE FCOA Comparison Tools:

As described in the last issue of this Gazette, BBE's Genetic Algorithm (GA) can quickly nominate a large number of war-game-analyzed FCOA candidates. During initial performance testing BBE has consistently nominated over 400 FCOA candidates in less than five minutes using a Dell XPS M1710 laptop. Since this is a much larger number of FCOA candidates than battle staff planners traditionally compare, BBE provides several FCOA evaluation tools to enable users to quickly understand the relative advantages and disadvantages of each candidate.

Standard BBE Search Results:

As displayed in the diagram below, BBE evaluates every FCOA by war gaming it against each of the Enemy Courses of Action (ECOAs) developed during IPB. BBE further assesses each war-game using the Commander's Desired End-State Evaluation Criteria, highlighted in blue below. Using the Evaluation Criteria and ECOA weights (provided by the Commander and the intelligence officer) BBE develops a cumulative score for each candidate solution - 785.9755 for FCOA Tukhachevsky in the diagram below.

Using the cumulative-score technique described above, BBE's GA 'breeds' new candidate solutions by



Evaluation Criteria	Wt	ECOA Auerstadt	ECOA Jena	ECOA Leipzig	Cum
ECOA Relative Probability:	-->	1.0	1.5	2.0	
Maximize Overall Attacker Strength	1.0	50.04117	78.448006	112.44142	240.93...
Minimize Overall Defender Strength	2.0	109.97629	170.96075	228.73805	509.6751
Maximize Atk Strength at OBJ Sayers	1.0	0.0	0.0	0.0	0.0
Maximize Atk Strength at OBJ Payton	2.0	0.0	0.0	0.0	0.0
Maximize Atk Strength at OBJ Butkus	2.0	0.0	0.0	35.36983	35.36983
ECOA Score (this FCOA):		160.01746	249.40875	376.54932	785.9755

BBE consults the Commander's Desired End-State and the IPB ECOA set to provide evaluation scores for war gamed FCOA candidates.

combining various features of previously successful solutions within the breeding pool. After a few generations the GA will typically produce solutions that reasonably compare to those developed independently by experts. Of course, BBE still allows expert users to nominate specific FCOAs, and to even 'spike' the breeding pool with those expert-nominated FCOAs. However, in anecdotal user-tests to date, BBE has never failed to improve upon expert-nominated FCOA's.

When the user stops the genetic algorithm, BBE returns the final generation of FCOAs from the breeding pool, along with the 'Cream-of-Crop' FCOAs from all generations. The default size for the breeding population is 400 solutions, and the default size for Cream-of-Crop is 20 solutions. BBE rank-orders each of these 420 solutions by the cumulative scores from the war-game evaluations. At this time the Commander can simply choose an FCOA, typically from one of the top-ranked candidate solutions. Or, prior to making a decision, the Commander can direct his staff to use the three BBE FCOA Comparison tools

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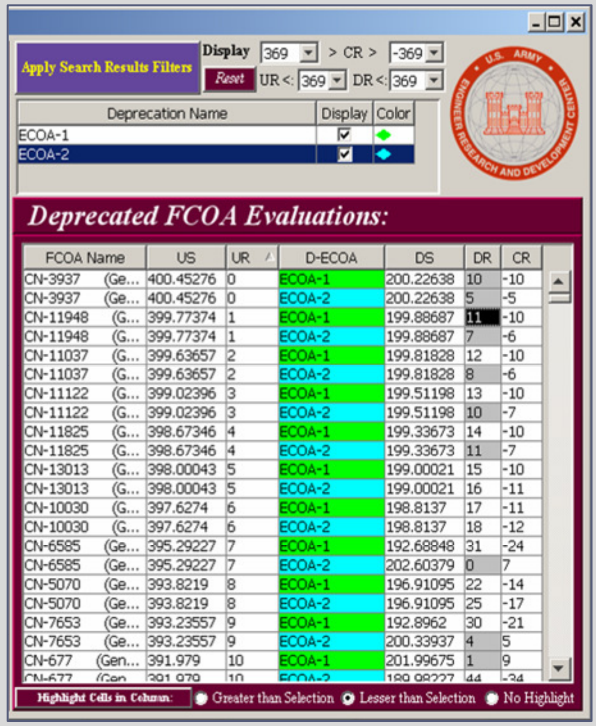
to better understand the strengths and weaknesses of the various FCOAs.

Risk Deprecation Analysis:

Even if the intelligence staff develops a superb set of ECOAs during IPB, the relative probabilities of those ECOAs will not reflect the game-theoretic relationships to the FCOA candidates, with respect to the Commander's weighted Evaluation Criteria (Desired End State). In other words, a particular FCOA may be especially vulnerable to a particular ECOA, regardless of the likelihood of that ECOA. If that FCOA is ranked high overall, it is probably due to being optimized against the remaining ECOAs.

In the BBE screen grab to the right, the Computer-Nominated FCOA-6585 is originally ranked 7th against both ECOAs, but is ranked 0th (best) when ECOA-2 is deprecated.



Risk Deprecation enables users to understand FCOA vulnerabilities relative to ECOAs.

In other words, CN-6585 is the single best FCOA against ECOA-1, but is ranked lower overall due to it's vulnerability to ECOA-2. If the commander particularly likes the concept and scheme of maneuver behind CN-6585, he might ask the intelligence officer if he can provide early warning of enemy adoption of ECOA-2. This would lead to an associated Priority Intelligence Requirement (PIR), and the likely development of a branch-plan, to be triggered in the event of ECOA-2. If the staff determines the branch-plan and decision-point to be reasonably feasible, this might lead the commander to accept the risk inherent in FCOA CN-6585. Thus, BBE provides commanders a powerful tool to calculate risk.

Evaluation Criteria Deprecation Analysis:

In a methodology similar to the risk-deprecation analysis process described above, BBE also provides a tool to understand each FCOA's sensitivity to each of the Commander's Desired End-State Evaluation Criteria. To continue the FCOA Tukhachevsky example described above, the staff might find an (overall) average FCOA that does extremely well against all of the Commander's Evaluation Criteria, with the exception of Objective Butkus. This new understanding might prompt the commander to re-consider his double-weighting of Objective Butkus, particularly if he likes the overall advantages of that FCOA, relative to the other evaluation criteria.

Pareto Trade-Off Analysis:

The two deprecation analysis functions are rather coarse tools for determining FCOA sensitivity to ECOA's and the Desired End-State Evaluation Criteria. They are good at empowering the staff to quickly identify a small set of interesting FCOA's for further examination. However, these two tools are not as good in determining which of the remaining FCOAs best leverages the trade-offs inherent in the ECOAs and the Evaluation Criteria.

A pareto analysis surveys the trade-offs between independent (no weights needed) evaluation criteria. In a consumer-choice example, Automobile-A may be extremely good in quality, but also high in price. Many

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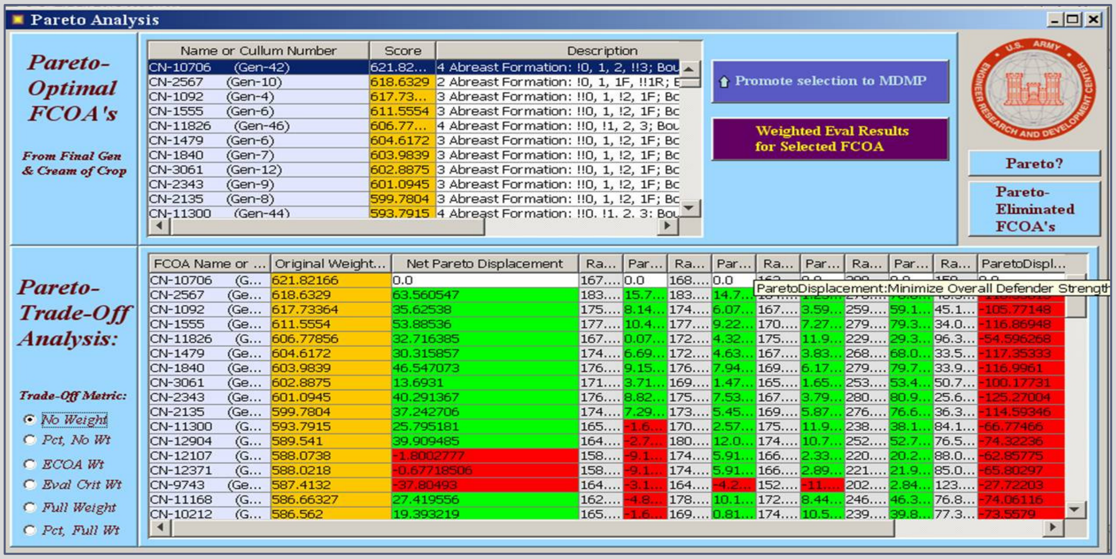
people would choose Automobile-B if it's only 1% less in quality, but 50% less in price, even if they originally quadruple-weighted 'quality' as their metric, over price.

In this spirit, BBE's Pareto Analysis functionality enables the commander and staff to look for intelligent trade-offs for the already-desirable small subset of FCOA's, developed in the rough deprecation analyses. The Pareto Analysis compares each FCOA's specific evaluation criteria against the specific criteria of every other FCOA, without using the original evaluation weights.

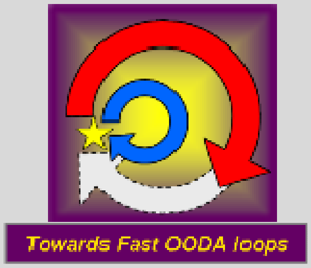
As displayed in the diagram below, CN-10706 is the top-ranked FCOA using the original cumulative weights, but the pareto display below shows that FCOA's advantage deriving specifically from the objective of minimizing the defender's strength. However, each of the next eleven ranked FCOAs 'trade-off' relative weakness in that criteria with improved performance in the first four evaluation criteria. A minimally trained user can see this at a glance by the red and green codings in the lower table.



BBE's Pareto Analysis functionality enables the commander to quickly find intelligent 'Trade-Off's' to improve already-desirable FCOAs.

With a modest amount of training, battle staff planners should be able to use the Deprecation Analysis tools to find FCOAs that have interesting strengths and weaknesses. The planners would then use the Pareto Analysis tools to find the FCOAs that trade-off small weaknesses in favor of big strengths. Since the Pareto Analysis takes a minute or two per FCOA, planners wouldn't use this final technique to cull a large set of FCOA's into a smaller set.

The net effect of BBE's GA and FCOA comparison tools is to enable commanders and their battle staffs to ***significantly accelerate*** the middle steps of MDMP: Step-3 COA Development, Step-4 COA Analysis, and Step-5 COA Comparison. There will be additional time-savings if the staff uses the BCV war-game visualization to conduct mission rehearsals. In our estimation, this will make our OODA (Observe, Orient, Decide, Act) mission cycles much faster than before.



"You can ask me for anything you like, except more time."

- Napoleon, to a staff officer, 1803

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Project Update:

The BBE research prototype is the result of 18 months of spiral development guided by a review panel of seven military subject matter experts. As is typical for spiral efforts, the overall design is not as coherent as the Army would like for a production model. An example of this is the loose integration between BBE, and its visualization component, BCV. In its current configuration, users must save an XML file for each war-game session to a hard drive, which an independently launched ArcGlobe later accesses for visualization. In a production model, we would like to replace this lengthy, several-click process with a single click. Users would select an FCOA and an ECOA within a single application, and see an immediate war-game animation.

Later this year the Defense Services group within ESRI will begin developing a production model of BBE, which will eventually enable programs-of-record to integrate BBE and ESRI objects into legacy program software environments. TEC developers will continue to collaborate with ESRI developers to maintain savvy battlefield reasoning engines in the tactical context of MDMP and IPB. The BTRA-BC program plans to install an initial BBE prototype into the JGES lab for system integration with other projects like GeoBML. We hope to identify a TRADOC organization to facilitate user studies of this exciting new tool.

Please contact the BTRA-BC Program Manager, Mr. Dan Visone, if you would like to influence, or participate in future BBE development.

BBE demonstrates the power of a decision tool that leverages automated terrain analysis products. This provides 'cognitive amplification,' which enables staff planners to significantly improve the speed and quality of their IPB and MDMP processes.

-Mr. Michael Powers, Technical Director,

Geospatial Research and Engineering
Engineer Research and Development Center

Breaking News!

Program Manager Force XXI Battle Command Brigade & Below (FBCB2) and TRADOC Capabilities Manager Platform Command have given the go-ahead on the initial integration of the BTRA Movement Projection Engines into the CJMTK version of FBCB2. Work is under way through the BTRA CJMTK Extension program to work closely with the PM & TCM during the integration to ensure valuable and user-friendly routing capabilities to the war fighter

BTRA CJMTK Extension (BCE) Development

- by Scott Clark

BTRA-BC Engine Transition

The BCE team is on the home stretch to delivering the first set of BTRA-BC engines. The goal is a June delivery to CJMTK. The delay is due to some additional work being done on the Standard Mobility engine, and alignment of the schedule so that the C++ Maneuver Network Generator can be released with the rest of the engines.

Standard Mobility is undergoing some enhancements to support the DTSS Cross Country Mobility requirements. This is a joint effort between the BCE team and GSL. The new Standard Mobility engine will work in conjunction with the CCM engine currently under development by the BTRA-BC team. New features will include capabilities to identify the season, weather conditions, and driver visibility.

The Maneuver Network Generator development continues on schedule and testing on large datasets will occur throughout May. This will provide us the information we need to determine how large a network can be built.

In addition, some updates have been made to the Complex Generator and Concealment Generator functions to handle greater numbers of features. This sort of stability is key to being able to build larger networks.

Coalition Warrior Interoperability Demonstration 08 Update

The CWID effort culminates in June with the actual demonstration. Additional work has gone into the Movement Projection client RISA and the Java Framework to ensure the best user experience for CWID. This includes usability as well as stability enhancements. In addition, a Windows installer is being developed for the Java Framework and Movement Projection toolbar. This will really be the first opportunity for war fighters to use the CJMTK RISA and Movement Projection RISA and provide feedback.

Howard University and Systematic

- by Harland Yu

Howard University graduate students, in partnership with James Muguira from Systematic Software Engineering, Inc., have been hard at work authoring a paper detailing the use and change of the JC3IEDM over time. This paper will be submitted to the 2008 Fall Simulation Interoperability Workshop. Additionally, James and another Systematic engineer, Corbin Jones, are examining how the team might integrate or otherwise leverage the technology and capabilities of the SitaWare C2 system within the GeoBML Testbed architecture.

Replication/Synchronization Experiment #2

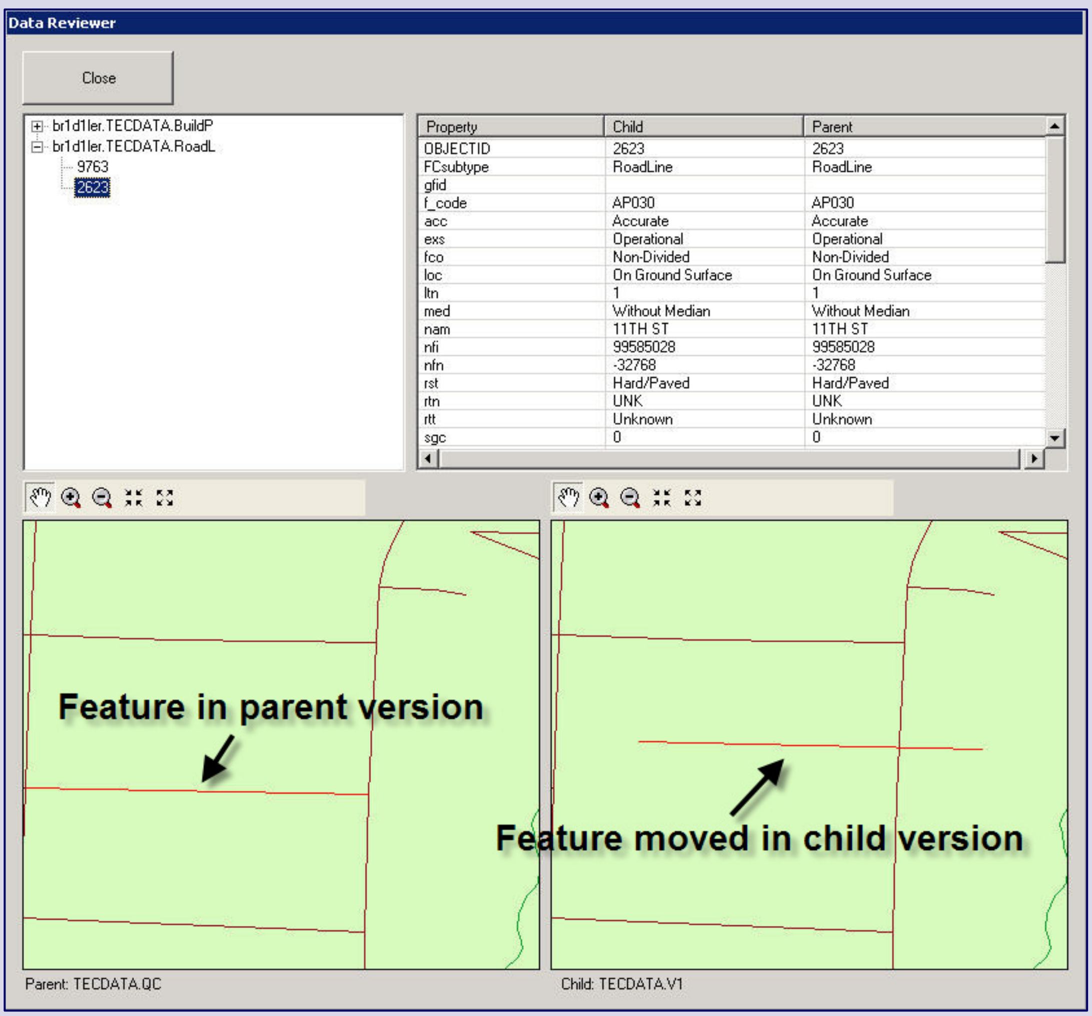
- by Doug Caldwell

The Joint-Geospatial Enterprise Services (J-GES) Replication/Synchronization Experiment #2 is currently underway. Most of the experiment has been completed at this time, but the final wrap-up will occur in late May or early June. This experiment built on the lessons learned in Replication/Synchronization Experiment #1 and focused on the key recommendations. Three new capabilities were tested: improved automation and customization, data review, and mobile data collection.

Participants included the Topographic Engineering Center's J-GES Program and Operations Division, the U.S. Army Maneuver Support Center (MANSCEN), the National Geospatial-Intelligence Agency (NGA), and ESRI. Replication and synchronization were performed at echelons from the National level to Below Brigade using a subset of the Theater Geospatial Database (TGD) covering Fort Polk, LA, and the Washington, DC area.

The replication/synchronization process was simplified with the automation and customization of the replication and synchronization tasks. Replication is the initial copying of a database, which involves the entire database. Synchronization is the updating process, which only involves changes to the database. As observed in Replication/Synchronization Experiment #1, the technical aspects of the process work correctly. Replication/Synchronization Experiment #2's customization resulted in a simplified process for the specific steps for replicating and synchronizing databases, but testers observed that the overall process of managing data, which included a manual review of changes, still involved a large number of steps. Future experiments will focus on simplifying the larger process.

One highlight of the experiment was the successful development of a new Data Reviewer tool. This tool allowed operators to review all changes to the database prior to synchronization. Previously, changes could only be made to the database when conflicting edits were made. Non-conflicting edits were not easily available for review. Using the Data Reviewer tool, users could graphically see changes in the geometry of different versions. Changes to attributes were also highlighted. The tool was transferred to the Combat Terrain Information System development team in late April.



Data Reviewer tool showing changes between parent and child versions of a database.

Mobile clients were added in Replication/Synchronization Experiment #2. Using ESRI Mobile Application Development Framework (ADF) and ArcGIS Server software, Below Brigade clients were able to create, delete, and modify point, line, and areas features using a Motorola MC35 cell phone and wirelessly synchronize the data with the Brigade database. The testing demonstrated the basic functionality, but a number of fixes and enhancements will be required before this technology will be robust enough for field application.

Based on user feedback, modifications to the tools were made throughout the testing. The experiment will conclude with a final retest of the revised tools, followed by the delivery of the After Action

Upcoming Replication/Synchronization Experiment #3

- by Doug Caldwell

As Replication/Synchronization Experiment #2 winds down, the Joint-Geospatial Enterprise Service (J-GES) team is gearing up for Replication/Synchronization Experiment #3. Preparations and requirements gathering are already underway.

Replication/Synchronization Experiment #3 will primarily focus on the link between the four Geospatial Production Cells (GPCs) and the National Geospatial-Intelligence Agency (NGA). While the concept is still under development, the current thought is as follows: GPCs will provide Theater Geospatial Data (TGD) to an NGA TGD staging database, where quality assurance will be performed. NGA will make minor edits and synchronize them with the GPCs, while major edits will be sent back to the GPCs, corrected, and then synchronized with NGA. NGA will take the final changes, store them in a separate approved version of the database, and transfer the approved data to the Geospatial Intelligence Feature Database (GIFD), where it would be available to DoD customers. This current concept will likely change and evolve with additional discussions. Replication/Synchronization Experiment #3 will result in an initial design and workflow for the exchange of data, as well as an experiment testing the design.

A second focus area of Replication/Synchronization Experiment #3 will be a review of the Concept of Operations and current design for the exchange of data from Theater to lower echelons. The results of Replication/Synchronization Experiments #1 and #2 have revealed a process that works technically, but which is complex, involves a large number of steps, and is difficult to manage. The current approach will be reviewed in detail, assessing the strengths and weaknesses of the technology, alternative approaches, and changes to the current business practices and workflows.

In addition to the review, the J-GES team will collect data on the anticipated bandwidth requirements for the replication/synchronization process. This effort will be coordinated with the GPCs and US Army Signal School, in order to insure that the proposed technical solution can be executed operationally.

Results from Replication/Synchronization Experiment #3, including the GPC/NGA design, experiment, and review of the current CONOPS should be available later this year.

J-GES Value Experiment #2:
Evaluation of Advanced Automated Geospatial Tools in a Mission Context

- by Andy Powell

Summary: Value Experiment #2 is a direct follow-on to Value Experiment #1 which assessed the value added of Advanced Automated Geospatial Tools in a terrain analysis scenario. The specific purpose of Value Experiment #2 is to further assess the value added of Battlefield Terrain Reasoning and Awareness – Battle Command (BTRA-BC) tools in a military planning scenario. In this experiment, sixteen U.S. Army junior officers (O3-O4) with staff planning experience will be tasked to perform identical, complex planning tasks on similar terrain using Commander's Support Environment (CSE), an advanced Command and Control (C2) system, with and without BTRA-BC functionality. A statistical analysis will be performed on the data gathered.

Environment: Originally sponsored by DARPA, CSE was developed by Viecore, FSD, Inc. in response to the Future Combat System (FCS) requirements of mobile C2. Combining sensor data, intelligent agents, and simulation capabilities, CSE provides a commander's staff with the tools to filter, assess and respond to critical battlefield information.

Experimental Design: The experiment is structured as a within-subjects design (i.e. participants will perform similar tasks using CSE with and without BTRA-BC). The tasks involve planning a maneuver schema for the companies of a Brigade Combat Team (BCT) battalion. The tasks include terrain analysis, route planning, concealment analysis, selecting hide and battle positions, evaluation of possible hostile force Courses of Action (COA), and Named Area of Interest (NAI) generation. The order of the with BTRA-BC and without BTRA-BC trials and the order of the scenarios will be counter-balanced and randomly assigned in order to control for the effects of these parameters in our analysis.

Hypotheses: The experiment is designed to test the following hypotheses:

- The participants perform tasks faster with BTRA-BC than without BTRA-BC.
- The products produced by participants are of higher quality when using BTRA-BC than without BTRA-BC.
- The knowledge and understanding of the effects of terrain on decision-making are at least as good for participants using BTRA-BC than for those not using BTRA-BC.
- The participants believe BTRA-BC helps them to complete tasks faster, produce higher quality output, and their knowledge and understanding of the effects of terrain are as good as when not using BTRA-BC.

The value added of BTRA-BC tools will be assessed by the following measures:

- Time to task completion: This measure was highly significant when evaluating Tier 1 tools, but the opinion of SMEs' is that with more complex problems the participants will use all the time available to refine their products. Therefore this measure may not be as significant in Value Experiment #2.
- Subjective quality of the output: Subject matter experts (SME) will evaluate the information presented and the clarity of the presentation of the output. Because of (1) above this may be the most important of the measures.
- Knowledge of the impact of terrain on the military problem – SMEs will evaluate the participants' answers to questions requiring reasoning about the terrain.
- Participants' perception of the value of AAGT – Participants will complete a questionnaire designed to elicit these perceptions of BTRA's effect on how quickly they can produce planning products, the quality of their products, and their terrain understanding.

Experiment#2 will be conducted in two groups. The first of these was conducted on 16-17 APR 08 and the second one is planned for the summer.

J-GES Value Experiment #2:
Evaluation of Advanced Automated Geospatial Tools in a Mission Context

- pictures by *Michael Timms*

Building the plan

Viecore FSD provides training on the CSE

George Mason University provides support

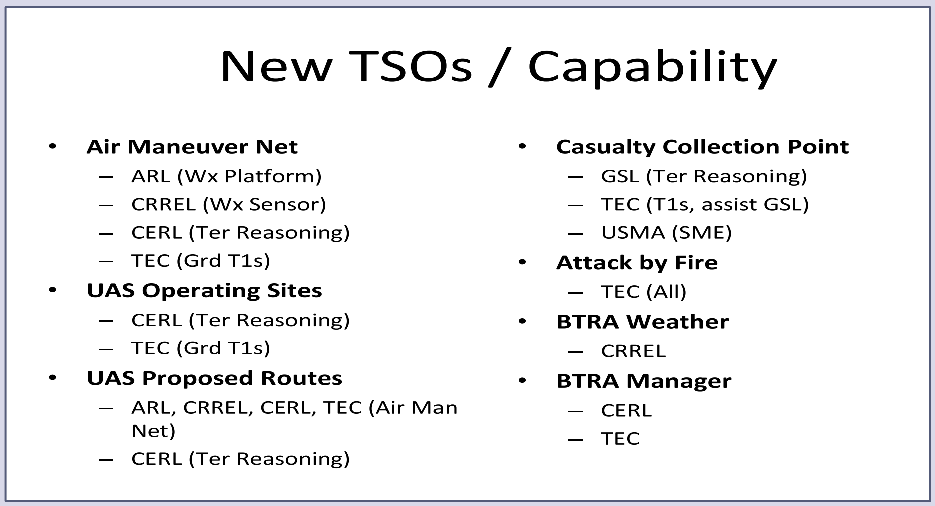
Soldiers participate in the experiment

George Mason University collaborating

GeoBML ERDC Wide Demonstration

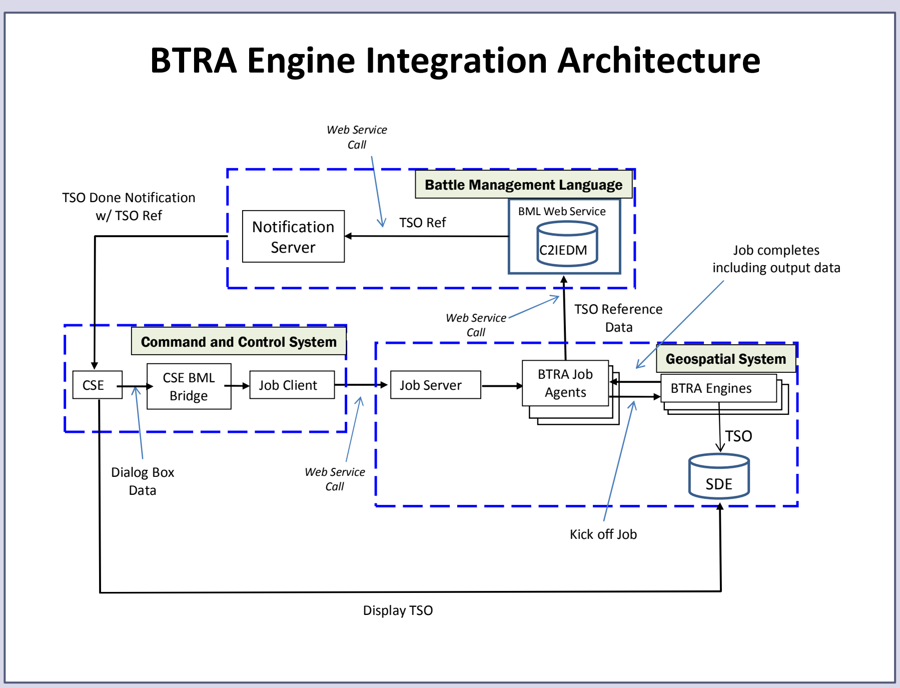
- by Harland Yu

During the second week of April, the GeoBML assembled to prepare for a demonstration that showcased the culmination of a six month long collaboration between five Army labs (ARL, TEC, CERL, CRREL, and GSL), the United States Military Academy at West Point, and numerous contractors (ACS, George Mason University, Howard University, TechProjects, and Viecore FSD). The actual demonstration was held on April 11 to an audience of key leaders from across the ERDC. The agenda focused on the operational basis and scenario for GeoBML, the software architecture that was designed and implemented in order to fulfill those operational needs, a walkthrough for a potential use case of multiple TSOs during mission planning, and a detailed discussion of the algorithms behind the weather effects analysis and the UAS operational sites and route planning TSOs. The new capabilities that were demonstrated are listed below.



Martin Kleiner (GMU) gave a short overview on the TRADOC-approved operational scenario – a fictional storyline that unfolds in the Caspian Sea region. The demonstration concentrated on the mission for the 3d Stryker Brigade Combat Team (3SBCT). This provided the framework for developing the software that fulfilled multiple operational requirements and possessed instant value in the military decision making process.

Harland Yu (TEC) briefed the attendees on the software architecture used during the demonstration. Essentially, the architecture provided an environment where different TSO engines could be plugged in to handle multiple requests from a user at a command and control system. A diagram showing the demonstration configuration is shown below.



Mr. Kleiner then presented a sample workflow combining the use of separate Tier 2 TSOs – Attack By Fire, Casualty Collection Points, and Movement Projection – that supported an Infantry Stryker company's planning process for an attack mission. This involved selecting an appropriate direct fire position relative to a specified objective, determining a usable area for gathering casualties, and refining that casualty collection point based on a route generated from the line of departure to the attack by fire position.

Kirk McGraw (CERL) and Sean Mackay (CRREL/AER) provided an in-depth

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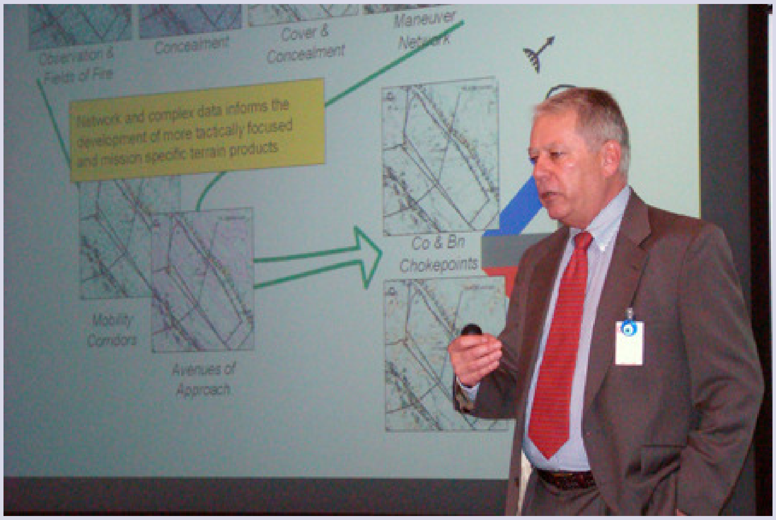
look at the concepts and algorithms behind the UAS Operational Sites and UAS Routing TSO engines. By incorporating the mission context information and weather effects on platforms and sensors, this capability enabled the planner to determine optimal routes for a particular UAS platform, given the weather forecast, time duration of the mission, and set of observation targets on the battlefield (NAIs or named areas of interest).



Martin Kleiner discusses OAKOC products

Recent Events ....

BTRA BC:

CJMTK User Conference Presentation - April 08

Colonel Moore Visit - April 08

BTRA Architecture Experiments - Apr-May 08

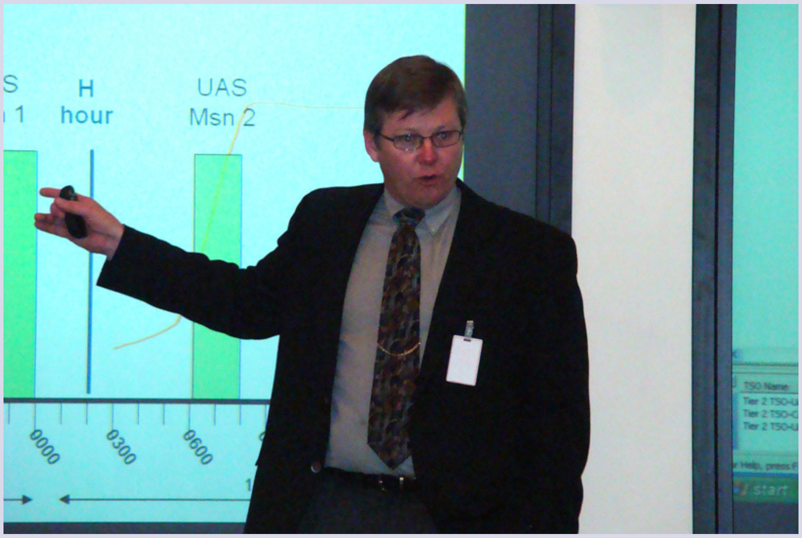
ERDC-Wide GeoBML demo -May 08

J-GES:

CJMTK User Conference Presentation - April 08

J-GES Value Experiment #2 - April 08

Replication/Synchronization Experiment #2 - Mar-May 08



Eric Nielson discusses the scenario

Kirk McGraw briefs the CERL Air Maneuver Network and UAS Routing Tactical Spatial Object

- pictures by *Michael Timms*

Upcoming Events…

<u>BTRA BC:</u>

Geospatially-Enabled Battle Command Workshop
June 2008

BTRA Engines available via CJMTK
June-July 2008

BTRA Engine Architecture Experimentation
Ongoing

BTRA BCE presentation at the ESRI UC
August 2008

GeoBML demonstration at the ESRI UC DIET
August 2008

<u>J-GES:</u>

Replication/Synchronization – Experiment #3
June 2008

CTIS Joint Service Baseline Assessment
June 2008

CTIS/CMB/CGA/ experiment
July 2008 - Test loading and use data from both the CMB and the CGA

J-GES Value Buckeye Experiment #3
August 2008
Ft. Benning, GA

J-GES presentation at the ESRI UC
August 2008

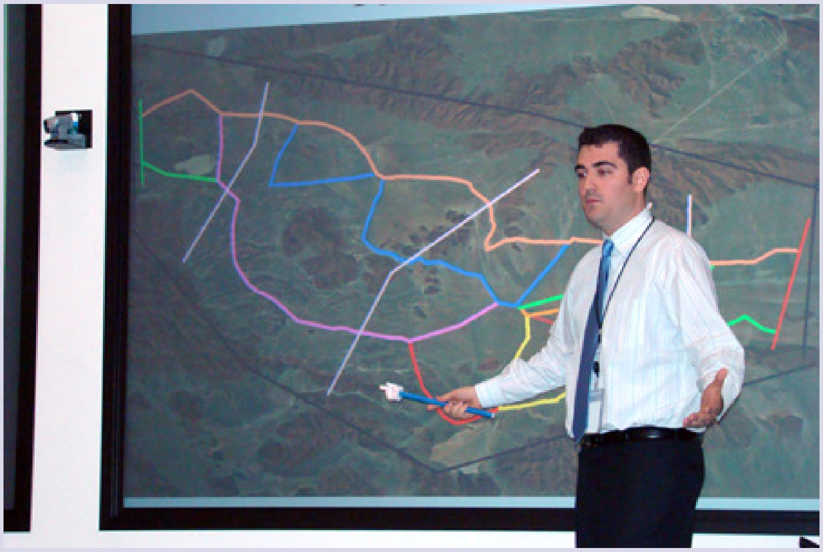
Sean Mackay discusses the integration of weather ef-

Harland Yu discusses the BTRA architecture design

Major Rainey discusses the Casualty Collection Point TSO

Jerry Schlabach briefs the BTRA Battle Engine (BBE)

Ken Braswell discusses the innovative use of terrain in the BBE



Adam Kuchinski discusses the use of the ground maneuver network in the BBE

BTRA-BC Research and Development at TEC: Providing Advanced Geospatial-Based Military Analysis Products

- By Adam Kuchinski

The goal of the BTRA-BC team at TEC is to perform research and development that supports the Army's mission by building advanced geospatial analysis products that help increase the effectiveness of the Military Decision Making Process (MDMP). These products, called Tactical Spatial Objects (TSOs), result from the collaborative efforts of our team of software engineers, GIS analysts, and military Subject Matter Experts (SMEs).

The BTRA-BC TSO Process begins with the team of SMEs analyzing military doctrine and practices to find elements of the MDMP that could benefit from the development of a particular TSO. Once a TSO has been identified, the SMEs accumulate the relevant doctrine into a High Definition Document (HDD), which not only describes what the TSO is, but also the specific set of Mission, Enemy, Terrain & Weather, Troops & Support Available, Time, and Civil (METT-TC) factors that the object is dependent upon. The BTRA-BC development team then works closely with BTRA-BC's Military Terrain SME to generate a prototype software product utilizing GIS technology. This prototype is presented back to the entire team of SMEs, at which time they evaluate the effectiveness of the prototype in communicating the key spatial and tactical information of the object to the war fighter. Once the prototype is approved, the TSO moves to the development phase and a software engineer finalizes and tests the code, completes an engineering document that details the purpose of the TSO and how to use it, and delivers this package to the BTRA CJMTK Extensions (BCE) team. The BCE team then prepares the TSO for distribution to the CJMTK developer community by conducting further testing and building Reference Implementation Sample Applications (RISAs) that will be downloadable from the CJMTK website.

TSOs currently being prototyped or developed at TEC include the following:

- **Ambush Areas**: An engine to identify locations possessing high potential for an ambush
- **Assembly Areas:** An engine to identify locations suitable for the assembly of heavy maneuver forces
- **Attack By Fire**: An engine that considers various factors to identify suitable locations for an attack by fire operation
- **Choke Areas**: An engine that analyzes the terrain to determine the maneuver choke points of different echelons
- **CCM/ORM**: Products that provide cross country and on road mobility scores
- **Dismounted Maneuver Network:** Generates a transportation network to project movement by dismounted troops
- **Engagement Areas:** An engine to identify areas suitable for use in conjunction with a firing position

Indirect Fire: An engine to identify locations suitable for indirect fire support

Websites:

http://www.tec.army.mil/btra/index.html

http://www.tec.army.mil/JGES/index.html

Terrain Data Inferencing for Maneuver and Gap Crossing Predictions

By Alex Baylot

The old cliché in the computer industry, “garbage in garbage out” is all too much a reality. The quality of computer models predictions or computations is highly dependant on the quality of the input data. The same is true for the fidelity of the model. The fidelity of the modeled result is dependant on the fidelity of the input data.

This year we are heavily investing in research towards improving the quality of the terrain data needed for maneuver and in particular gap crossing predictions. Currently, the Standard Mobility Model (STNDMob) Engine of BTRA has more than enough fidelity to model the mobility of ground vehicles over roads, cross-country, obstacles, and dry gaps. However, to improve upon the fidelity of the maneuver predictions, the improvement will need to come from the terrain data.

Until recently, one of the key terrain parameters for deciding cross-country speed, soil strength was estimated with minimum fidelity and did not adequately consider the climate of the area-of-interest (AOI) nor the rainfall conditions. These improvements are now incorporated into a new and second method called “inferSoilStrength.” It requires the terrain parameters; USCS soil type, Trewartha Climatic Region Subtype, slope, latitude, and feature code. The Region Subtype is a worldwide parsing of the world into regions or zones that exhibit similar precipitation/temperature conditions. This database was recently made compatible with the BTRA environment and was accomplished via a joint effort with GSL, TEC, and Northrop Grumman. The latitude is needed to determine whether the AOI is located in the Northern or Southern Hemisphere. Most of the inference tables are indexed on north/south hemisphere for each Region Subtype. These tables of soil strength were computed from many of the same equations as the FASST model discussed in a previous article by the CRREL and will serve well as an intermediate fidelity of soil strength until FASST is integrated into BTRA. It is also capable of serving other applications such as DTSS. In the future, FASST will offer more sensitivity to changing weather conditions, and winter weather impacts to the ground that STNDMob is already programmed to accept. Nevertheless, the new soil strength inferencing is a step in the right direction to improving the fidelity of the terrain data.

Another key terrain inference product recently developed, was driver recognition distance, known more widely as Visibility. For cross-country travel, this new method takes into account the season of the year to adjust the visibility based on the density of the foliage on the trees given the feature code and Region Subtype. However, if the user is aware of a limiting visibility condition due to obscurants (natural or man-made), nightfall, blackout operations, etc.; four pre-defined settings are available to select. These settings will limit on-road visibility and override the cross-country visibility if it is greater than the user set conditions.

Inferring the geometry of a gap is the next great objective and will be no small matter. The width of a gap is readily measurable from a satellite image, however the depth, bank height, bank angles, are a different matter. Research is being performed to give insight into ways of inferring this data. One such observation is that when the surrounding soil type is sandy, the bank angles and heights will tend to be low and when the soil type is rockier, the bank angles and heights will be steeper and higher, respectively.

While, this research for terrain inferencing is primarily accomplished for the benefit of maneuver prediction, it will serve other applications as well. Overlays for concealment or sensor performance can certainly make use of visibility levels/distances.

Battlespace Terrain Reasoning & Awareness - Battle Command (BTRA-BC) Tools Testing

by Larry Cook

Under the BTRA-BC program, mature BTRA-BC components will transition to National Geospatial-Intelligence Agency's (NGA) Commercial Joint Mapping Toolkit (CJMTK). Prior to any CJMTK transition, the BTRA-BC program will complete a performance and architecture evaluation of the BTRA-BC engines. Performance testing will consist of measuring execution metrics under various hardware configurations, terrain complexities, and input data sizes. Architecture evaluations will examine various CONOPS involving hardware resources, communications, and data access. In addition, the architecture evaluations will determine the optimum deployment of the engines using web services and/or embedded software on workstations.

The planned order of testing is:

Group 1 - Slope/Aspect and Complex Generator;

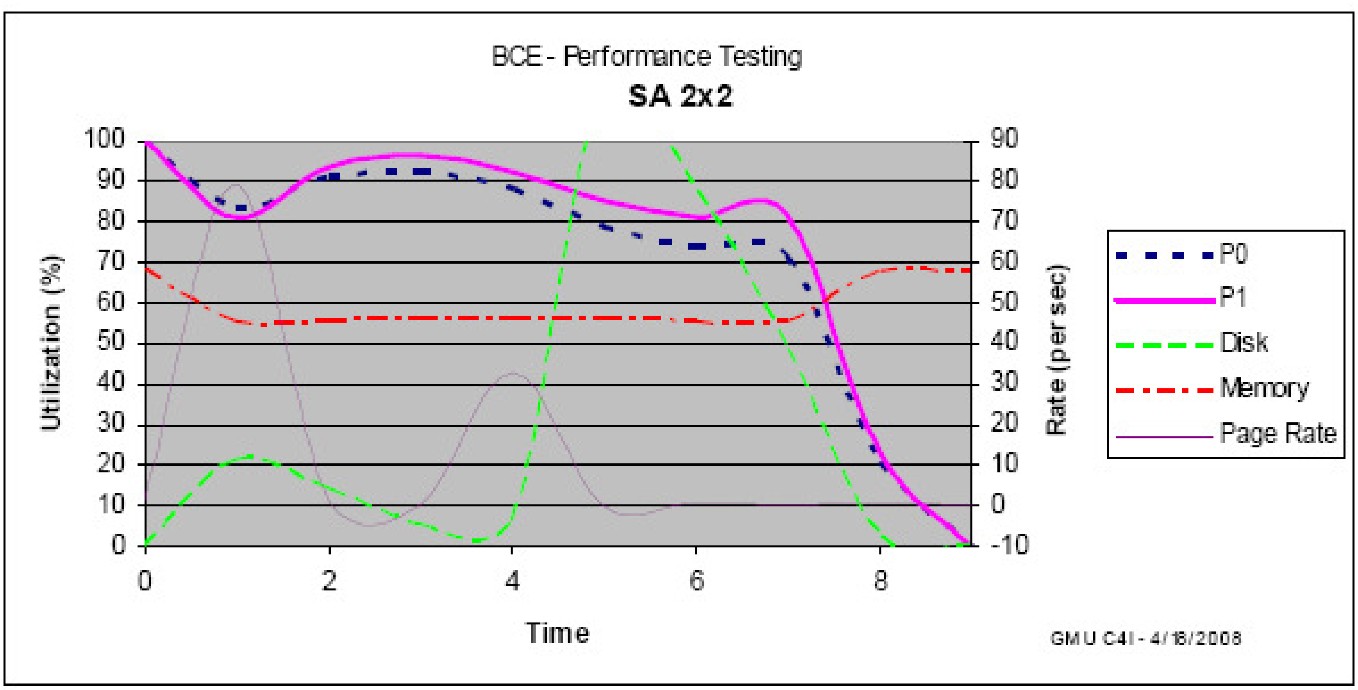
Group 2 - Standard Mobility, Obstacles, Concealment;

Group 3 - Network Generator;

Group 4 - Movement Projection;

Group 5 - Other Tactical Spatial Objects (TSOs) as they become available.

Researchers at George Mason University have begun performance testing of the Group 1 tools: the Slope/Aspect Generator and Complex Generator. The Slope/Aspect Generator creates a polygon feature class using Digital Terrain Elevation Data (DTED) as input and then calculates slope, aspect, and mean elevation for each polygon. The Complex Generator merges polygonal feature classes from Theater Geospatial Database (TGD) and the results of the slope/aspect generator into a single composite "Complex" feature class. This "Complex" feature class provides consistent geometry for information products, including sliver removal, and increases the performance of information generators. Initial testing of the engines is being performed



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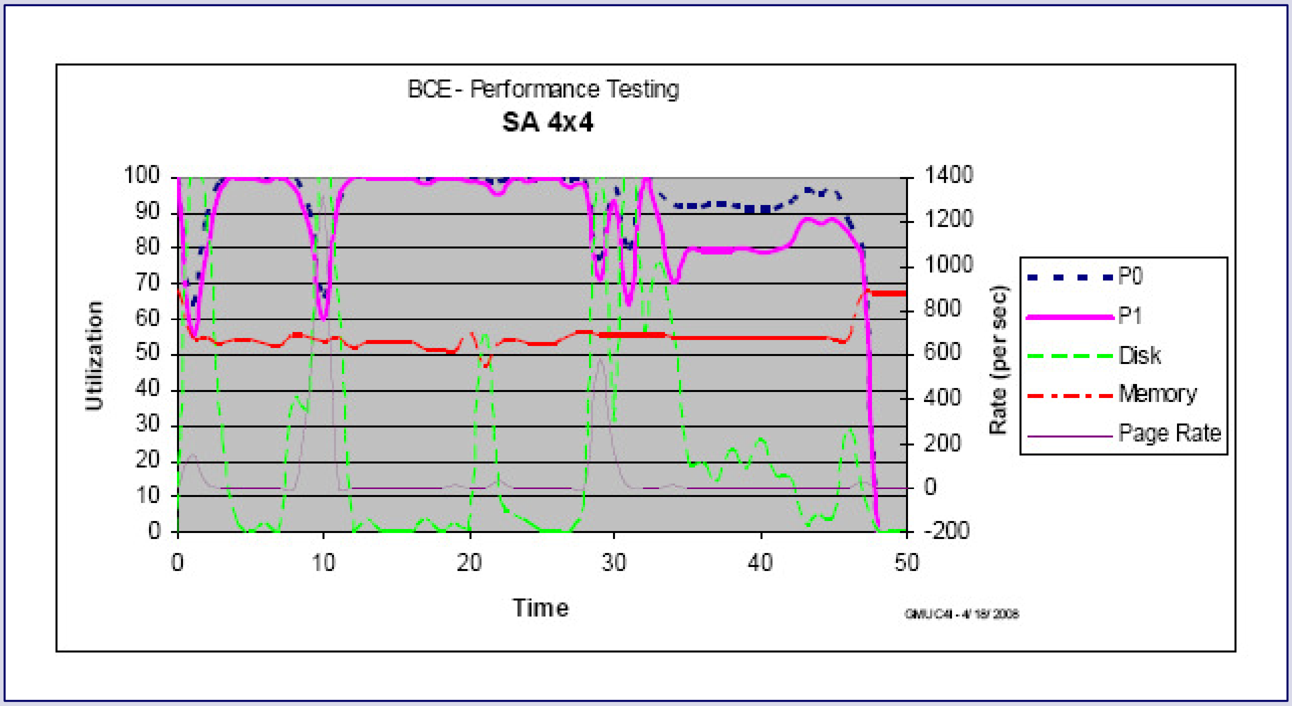

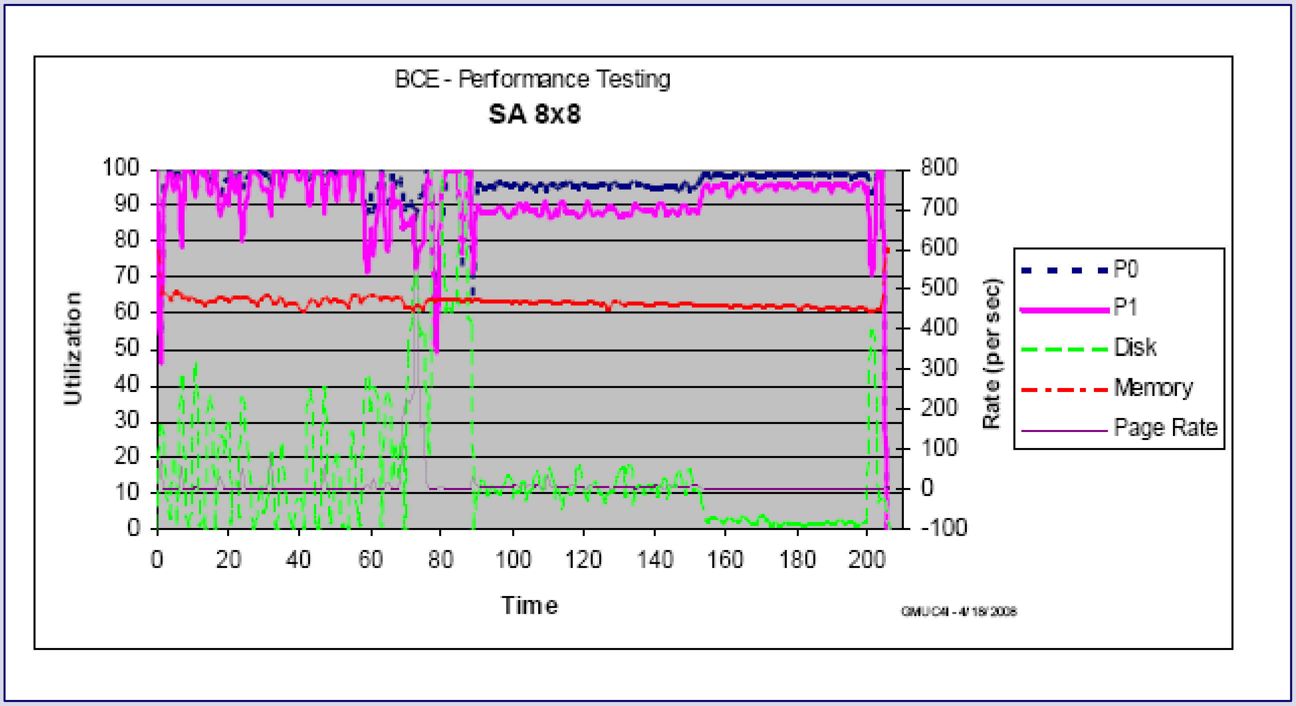

using data over Korea on a dual-core 2.7GHz machine with 2GB RAM, of which 1GB is dedicated to the engines.

Given various sizes of terrain data for processing, early results of the Slope/Aspect generator are shown in the following graphs. For the testing, the data sizes are in terms of 1:50,000 map sheets. For example, in the first Slope/Aspect engine test, the data area consisted of a 2x2 map sheet coverage area or the equivalent of four map sheets.

A variety of utilization statistics are collected during the performance tests. These include processor

Continued next page

(P0 and P1) and memory utilization, disk activity, and page rate. Page rate is the percentage of time a systems spends moving a memory "page" between memory and disk because of not enough memory. As paging increases, system performance decreases.

As seen in graphs above, the Slope/Aspect engine was CPU-bound during much of the run time (high utilization of P0 and P1), with several periods of high disk activity. As the data area increased in size, the process became even more CPU-bound. The test machine has 2GB RAM, with 1GB dedicated to the Slope/Aspect engine. Therefore, memory utilization of 100% means that system processes are using the entire 2GB RAM. For the Slope/Aspect engine testing, the graphs show total memory utilization greater than 50% in all three test cases, with the Slope/Aspect process consuming the dedicated 1GB RAM and normal Windows processes using a small portion of the remaining 1GB RAM.

Analysis of the performance of the all the BTRA-BC engines will assist in determining hardware requirements and trade-offs for optimal performance and where to provision the engines (embedded or as web services).

Distinguished Visitors...

March 19, 2008
Major Mike Cahill
Soldier Battle Lab

April 9th, 2008
Colonel David Moore
PM Battle Command
Colonel Al Mosher
TCM Platform Command

May 23rd, 2008
Adam McLennan
CW4 Robert Rounds
Robert Sames
GALE Program

Weather Strategy for BTRA

-By Michael Paquette

Weather is one of the principle input data products the BTRA system requires along with terrain characteristics. Use of weather enables the system to consider weather effects on the various tactical decision aids produced. Ensuring the availability of this temporal data in a readily usable format for ingestion by the BTRA tools is the focus of our weather work.

This summer we will be creating a design for a weather service whose job is to satisfy the weather data requirements of BTRA. Immediately after completing the design we well begin the development phase. Both of these efforts will involve staff from ERDC's Cold Regions Research and Engineering Laboratory (CRREL) and the Topographic Engineering Center as well as expertise from the Army Research Lab (ARL) at White Sands.

Our weather strategy is based on deployment in a DCGS-A environment. We are currently evaluating the suitability of the Joint Metoc Broker Language (JMBL) for satisfying the weather forecast data access requirements. Specifically, BTRA requires forecast data twice daily for approximately 25 parameters, limited to a particular area of interest.

Our strategy is also considering weather access in the event that communications are interrupted. During such an event, BTRA weather requirements would be satisfied using historical based weather conditions. For this reason, we are investigating the utility of Environmental Scenario Generator (ESG) at satisfying this need. ESG is a software system designed to allow a user to interact with archives of environmental data for the purpose of scenario extraction, data analysis and integration with existing models that require environmental input.

Lastly, we will be examining the costs and benefits of using higher resolution weather information to generate BTRA products. This fiscal year CRREL and ARL will experiment using 15 km, 5 km (if available), and 1 km weather data.

Standup of the Geospatial Information Office(r)/Geospatial Acquisition Support Office (GASO)

- by Mark Hainsey

Mr. Robert Burkhardt, Director of the US Army Topographic Engineering Center (TEC), was recently appointed as the Army's first Geospatial Information Officer (GIO). The GIO was appointed by the Headquarters Department of the Army Geospatial-Enterprise Governance Board (GGB).

The GGB was chartered by the Vice Chief of Staff – Army as a governance board to address Army geospatial enterprise issues impacting the current and future force. The GGB is a 3-star body, co-chaired by LTG Robert Van Antwerp, Chief of Engineers, and LTG John Kimmons, Deputy Chief of Staff, G2, chartered to facilitate the development of a net-enabled Army geospatial enterprise.

The GIO serves as the Army's central manager, responsible for coordination, assessment, and synchronization of all Army policies and standardization requirements for the geospatial information enterprise, which will enable interoperability across Battle Command systems, bringing the Army, Navy, Air Force and Marines closer to the realization of a unified Common Operational Picture (COP).

Effective 1 Feb 08, the GIO, at the direction of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASAALT) Military Deputy (MILDEP), stood up the Geospatial Acquisition Support Office (GASO) to provide engineering and domain expertise and support to the Army Acquisition Community (PEOs/PMs/PdMs) for implementation of the Army Geospatial Enterprise (AGE) (e.g., distributed geospatial data, architectures, policies, procedures, software, open standards, open data formats). In partnership with the Acquisition Community, TRADOC, and G3 LandWarNet/Battle Command, the GASO will provide support for implementation of geospatial enterprise policies, priorities, programs, production requirements, strategies and technologies, as an integral component of every weapon system acquisition. The GASO will ensure that the business processes of the Acquisition Community are enabled by the efficient implementation of the AGE and GI&S technologies. The GASO is organized to provide support in the areas of Systems Engineering and Geospatial Architecture design, Data Modeling, Requirements Analysis, and AGE Test, Validation and Certification. Additionally, the GASO will provide support to and work directly with the Modeling and Simulation community as it affects training support to the Acquisition Community. The objective of the GASO is to work directly with the Acquisition Community to ensure that the AGE is implemented properly to insure that actionable geospatial information is available from the soldier to the national level, horizontally and vertically, in support of planning and decision making.

The GIO has appointed Mr. Mark Hainsey (mark.a.hainsey@us.army.mil, 703-428-6734) as the Director of the Geospatial Acquisition Support Office. Mr. Hainsey is responsible for executing the mission of the GASO and is currently working with ASAALT to resource the GASO to execute taskings that have already been identified by the GGB. Near term focus areas include issues associated with the CJMTK licensing agreement, development of an Army Geospatial Data Model, and direct support of OIF/OEF activities.

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Architecture Experiment

- by Dr. Mark Pullen

The Distributed System Architectures experimental team from George Mason University (GMU) supports experiments to understand the effectiveness of TEC products in the networked environment that more and more characterize today's battlefield. Such systems have complex designs where processing, storage, and display to users are linked via networks. While the capacity of military networks to carry data continues to grow, the need to deploy networks in the tactical environment means that the networks used by TEC systems are significantly less powerful than the local area networks and Internet we enjoy in our offices and homes. Since TEC's products, available at the right place on the battlefield, can make a life or death difference, it is essential to understand how they can be used best in the networked environment.

A team from GMU's Center of Excellence in Command, Control, Communications, Computing and Intelligence (C4I Center) works in TEC's JGES facility to characterize the processing and network requirements of TEC systems. Currently they are working with the Battle Terrain Reasoning and Awareness (BTRA) project. They use advanced network emulation and testing systems from Shunra and Silk Explorer to determine the behavior of the BTRA systems under load. This information lets them project the interaction of BTRA applications with future deployed military networks. Assistant Professor Sam Malek provides analysis models of the networks, doctoral student Doug Corner conducts the experiments, and system administrator Nick Clark assembles systems for testing, all under the management of Professor Mark Pullen, who also is Director of the C4I Center. They are working with BTRA development contractors Scott Clark and Adam Kuchinski of Northrop-Grumman and TEC personnel Ken Braswell and Larry Cook. The team of academics, industry, and government personnel is cooperating to ensure that US soldiers will have the most advanced geospatial support that work well over future military networks.

Team Members…